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Investigating the impact of distance on the use of primary care extended hours

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Abstract

Introduction
Poor access to general practice services has been attributed to increasing pressure on the health system more widely and low satisfaction among patients. Recent initiatives in England have sought to expand access by the provision of appointments in the evening and at weekends. Services are provided using a hub model. NHS national targets mandate extended opening hours as a mechanism for increasing access to primary care, based on the assumption that unmet need is caused by a lack of appointments at the right time. However, research has shown that other factors affect access to healthcare and it may not simply be appointment availability that limits an individual's ability to access general practice services.

Objectives
To determine whether distance and deprivation impact on the uptake of extended hours GP services that use a hub practice model.

Methods
We linked a dataset (N = 25,408) concerning extended access appointments covering 158 general practice surgeries in four Clinical Commissioning Groups (CCGs) to the General Practice Patient Survey (GPPS) survey, deprivation statistics and primary care registration data. We used negative binomial regression to estimate associations between distance and deprivation on the uptake of extended hours GP services in the Greater Manchester City Region. Distance was defined as a straight line between the extended hours provider location and the patient's home practice, the English Indices of Multiple Deprivation were used to determine area deprivation based upon the home practice, and familiarity was defined as whether the patient's home practice provided an extended hours service.

Results
The number of uses of the extended hours service at a GP practice level was associated with distance. After allowing for distance, the number of uses of the service for hub practices was higher than for non-hub practices. Deprivation was not associated with rates of use.

Conclusion
The results indicate geographic inequity in the extended hours service. There may be many patients with unmet need for whom the extension of hours via a hub and spoke model does not address barriers to access. Findings may help to inform the choice of hub practices when designing an extended access service. Providers should consider initiatives to improve access for those patients located in practices furthest away from hub practices. This is particularly of importance in the context of closing health inequality gaps.

Keywords
distance; primary care; deprivation; access

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Introduction

In 2005, member countries of the World Health Organisation committed to developing health financing systems such that all people have access to health services, known as 'universal coverage' [1]. Health inequalities are observed within and between countries across the world – even in developed economies with sophisticated health infrastructures such as the UK. Health inequities arise through the circumstances in which people grow, live and age – and the systems which are put in place to deal with illness when it occurs [2]. Good access to the right health service systems for dealing with illness when it is needed is therefore a fundamental tenant of universal coverage.

The Greater Manchester area has the fastest growing economy in the UK, however life expectancy in the city region is lower than other parts of England [3]. There are also significant spatial differences in life expectancy across the city region with a male life expectancy varying by over a decade (between some of the poorest and the most affluent areas) [4]. There is an even larger effect of deprivation on the healthy life expectancy experienced by Manchester residents with a gap of over 18 years for men and 13 years for women between the most and least deprived wards [4].

In 2016, Greater Manchester became the first city region in the UK to sign a devolution deal and since 2017 has taken control of a £6bn health and social care budget [3]. Addressing the health inequalities experienced by the residents of the city is central to the aims of the Manchester devolution project and a priority for policy makers and politicians in the area. The devolution project has also provided an opportunity for academics to explore previously unavailable datasets - through partnerships with the local NHS trusts - as local politicians and care commissioners seek to understand whether services are improving and how best to meet the needs of the local population.

Since 2014, Greater Manchester has piloted and subsequently rolled out extended access to general practice services. The service forms part of the regions devolution and health and social care strategy [3]. The extended access service includes appointments that are offered in addition to the usual non-core hours services (out of hours GP appointments, walk-in centres, accident and emergency departments and NHS 111)[1]. These appointments are delivered in person by general practitioners and practice nurses. The appointments are held at 'hubs' which are distributed across the main population centres within Clinical Commissioning Group areas (CCGs –responsible for the planning and commissioning of health services in a local area). The extent to which same-day and/or pre-bookable appointments are available, the time of the appointments and the availability of different medical disciplines are specified by the CCGs.

Extended access schemes have also been piloted nationally since 2013 and form a key component of the NHS (England) strategy for primary care by 2020/21 [12, 13]. All English CCGs are expected to provide extended access in the evenings and weekends in line with local demand from 2020.

[1]Extended hours refers to normal primary care appointments offered outside of core working hours (9-6pm). This is distinct from out-of-hours services which are for emergency primary care. Out of hours services would include the NHS 111 service which might refer a caller to a GP led out of hours clinic at a central location such as a local hospital.

Extended access appointments have been motivated by two main factors: a perception that rising emergency department (A&E) activity is partly driven by poor access to primary care, and poor patient perceptions of access to primary care services. The UK in common with many other countries reports limited access to primary care outside of core hours (deemed to be 9am-5pm) [5]. The King's Fund [6] reported that the NHS is struggling to recruit and retain a sufficient number of general practitioners (GPs) to work in primary care. Majeed (2017) reported that 'GPs are a scarce resource' and that the NHS underestimates the shortage given the rising complexity of the role and the increase in patient need [7]. In the decade between 2003–4 and 2013–14, the number of A&E attendances rose sharply from 16.5 million to 21.8 million (32%) [8]. Research and Evaluation studies have found that extending access to primary care can reduce pressure on hospital settings [9, 10]. An Italian study using administrative data showed specifically that increasing the opening hours of primary care providers to 12 hours a day, resulted in a reduction in the rate of unnecessary emergency attendances of 10–15% [11].

While the evidence suggests extended access is likely to reduce A&E pressures, little is known with regards to the impacts the services have on patient perceptions of access. Studies have so far assessed uptake and use of extended access to understand which patients are being directly impacted. Whittaker et al. analysed the use of extended hours appointments in 5 clinical commissioning groups within Greater Manchester [12]. Using figures from the General Practice Patient Survey they showed that users of the extended hours service were typically younger than those using primary care services in core hours before the scheme was launched [12, 13]. Female patients were more likely to book appointments outside of core hours than males. Their study revealed significant spare capacity within the service and questioned whether this was the result of the way the service is delivered (e.g. via a hub model) or due to a lack of demand for the service.

There may be multiple reasons why spare capacity is seen in an extended access service. McIntyre et al. propose a conceptual framework of access as a multi-dimensional concept comprising three dimensions; availability, affordability and acceptability [14]. Under this, for good access there must be sufficient appointments such that there is availability. The patient needs to be aware that the appointments exist and attending an appointment must be affordable – not just financially but also in terms of the opportunity cost of time spent travelling and attending the service. Finally the service needs to be acceptable – patients need to be prepared to visit a practice or doctor who is not their regular GP, and GP practitioners themselves need to buy into this model so that it is promoted in their surgeries. The empowerment of an individual to use health care is affected by the different dimensions and barriers within these must be considered when determining whether or not a service is providing good access. Gulliford et al. report that groups may experience differing perspectives, needs and context which impact on their empowerment and so when considering the effectiveness of a policy, it is important to evaluate not just the supply of healthcare, but also the nature of the uptake and thus discover if any citizens remain marginalised [15].

Distance has been found to be a significant driver for health care use and feeds into the aspects of access (e.g. the affordability and acceptability domains) that may help explain low uptake of an extended access service. Haynes et al. (1999) found that distance is a factor in attendance rates at both primary and acute care sites [16]. Controlling for the needs of the local population and the existing health provision, distance from an emergency care provider had a marked impact on the rate of episodes, with the greatest reduction being seen in psychiatric cases (37% over the five distance quintiles within the study). Distance from a GP surgery had a similar effect, reducing elective acute episodes by up to 15%. The National Audit Office conducted a multilevel regression analysis of GP practice level rates of attendance at accident and emergency departments. Out of hours, patients from practices located nearer to accident and emergency attended more than those who were further away. This was shown by a rate of attendance that was 2% lower for every additional kilometre that the practice is further away [18]. These results suggest that access to services is not geographically equitable and that fair access to NHS services is dependent on geographical location being considered as part of the commissioning process.

Considering out of hours services, distance matters again. The out of hours service is often accessed by first making a telephone call, and then attending a hub service for an appointment. These are often located in emergency care settings such as at a local hospital. A study of telephone data from the Devon out of hours service showed that call rates to the out of hours service varied with the straight line distance from the caller to the centre. This study also included measures of rurality and deprivation. Those living in deprived areas called the out of hours service more often, however, the further away the caller was from the emergency care setting where an appointment would be taken, the lower the rates of calls [18]. GP cooperatives are typically based in emergency primary care centres, and patients are frequently required to travel to be seen. Geography is a key determinant of access, but little is known about the extent of geographical variation in the use of out-of-hours services. Further investigating the progression of out of hours calls to either telephone or in person management, Turnbull et al. used logistic regression to demonstrate that increased distance using a straight line measure was associated with telephone, rather than face to face management, highlighting potential geographical inequity in access to in-person services [17]. Berchet and Nader (2016) observed geographical factors in accessing out of hours care in an international study with a number of OECD countries reporting the same distance effect. O'Reilly et al. examined the effect of distance and deprivation on use of an out of hours GP cooperative in Northern Ireland with four centres. The study showed that calls to the service were proportional to proximity to the centres with those living further away, representing fewer calls even when controlling for confounding factors [21].

Raknes et al. examined the utilisation of out of hours health services by municipality in Norway, calculating distances from population centroids to service providers. The study concluded that distance was important in service uptake, even in acute cases and as such, extreme distances could impact patient outcomes [22]. Smits et al. examined a small sample (N=20) of general practices in the Netherlands, related to five cooperatives classifying use as 'high' and 'low' for out of hours care. Greater distance from the out of hours provider was associated with lower use at a practice level [23].

In addition to distance, there are other factors that may influence uptake. Patients who are registered at larger GP practices attend accident and emergency departments less often with research showing that for every additional GP, the rate of attendance for a practice reduces by 4% [19]. When there are more GPs, there is greater provision of core hours services and this means that fewer patients need to attend accident and emergency. It is reasonable to posit that the level of provision of core hours services is likely to affect the extent of extended hours service use in a similar way. Where GP time is scarcer, the use of an out of hours or extended hours services may therefore increase.

There is extensive research in the field of health inequalities which demonstrates that there are clear relationships between social disadvantage and poorer health outcomes. The World Health Organisation [2] reported that in all countries, health follows a 'social gradient'. Asaria et al. [24] showed that the inequality gap in the supply of primary care was reducing, but had not been eliminated by public policy. However more recently, Bostock [25] wrote that the primary care workforce in deprived areas is reducing at a faster rate than more affluent areas. It follows therefore that the number of GPs serving a community and the deprivation of the patients within that cohort are likely to be correlated and both may in turn be associated with the rate of use of an extended hours service. Where GP time is scarce and there is a higher level of deprivation, demand may be even higher.

Continuity of care is important and valuable to patients for both psychological and quality of provision reasons. The concept of a medical "home" was associated with better outcomes for patients in a cross national study which included the UK [5]. The results of a patient survey in six practices in Sunderland (UK) showed that for working age patients, a choice of appointment time was six times more important than a shorter waiting time. Patients with chronic illnesses valued seeing a GP of their choice seven times as much as having a shorter wait time. The research concluded that speed of access for many patients is less important than GP choice or timing convenience [26]. Therefore, we might expect that extended services would be more likely to be used if provided by the patient's home practice than by another practice.

The current study considers all extended hours appointments in 2016 from four CCGs within the Greater Manchester area and seeks to investigate the impact of distance on the uptake of extended hours appointments in primary care. We hypothesise that practices which are located further away from a hub account for fewer uses per capita of the extended hours service, than those which are located nearer and that therefore distance is an impediment to access. If distance is a barrier then it may mean that this service does not improve access for all and that this geographical inequality has the potential to widen underlying socio-economic inequality in access.

Methods

Data on extended access appointment provision and use were collected by CCGs and submitted to the National

Table 1: The Hubs, practices, and registered populations within the four CCGs included in the final dataset

CCG	Number of hubs	Number of practices	Registered population
1	4	37	227,267
2	2	35	238,924
3	2	41	243,828
4	6	45	247,842

Table 2: Variables in the analysis

Variable in the analysis	Values
use_rate	Number of service uses per 1000 registered patients
mean_age	Mean age of patients at the practice[2]
female_proportion	Proportion of patients registered as female
min_dist	Distance to nearest hub in miles to one decimal place
hubs	Hub = 1, Non-hub = 0
imd_decile	Decile of Indices of Multiple Deprivation (IMD) score for the LSOA in which the home registered practice is located.Decile 1 relates to the least deprived areas, decile 10 to the most deprived
GP_per_1000	Number of full time equivalent GPs (doctors) per 1,000 registered patients
supply_measure	Percentage of respondents who could not get an appointment the last time they called their surgery, because of the time, the data or the unavailability of their preferred GP. Weighted Responses taken from the GPPS survey, 2015
CCG(1,2,3)	Dummy variable to indicate the CCG of the practice

Institute for Health Research Collaboration for Leadership in Applied Health Research and Care Greater Manchester (NIHR CLAHRC GM) as part of an evaluation of extended access services being delivered in Greater Manchester throughout 2016 [27]. Seven of the ten Greater Manchester CCGs were funded by Greater Manchester Health and Social Care Partnership (GMHSCP) to implement extended access, however, one did not implement the service during the evaluation period and another did not submit data. In addition, one CCG did not include GP practice codes so could not be used, resulting in a dataset covering extended access services in four CCGs. The appointments data extend from 01 January 2016 to 31 December 2016.

In 2016, there were 158 unique general practices within the four selected CCGs. These were served by fourteen 'hubs' Table 1.

Counts of appointments were generated at the practice level, these were aggregated to generate uses of service at an annual rate. The outcome variable for the analysis is the number of uses per 1,000 registered patients at each practice. The dataset included 44,787 appointments of which 32,041 were booked and 27,747 were attended. Removing uses from practices outside of each CCG area, reduced the appointments to 25,408 useable records (appointments). These appointments were complete (zero missingness).

Practice codes [26] enabled several practice-level characteristics to be matched into the data, these include:

- Practice postcodes [28]
- Index of Multiple Deprivation (based on postcode mapped to Lower Super Output Area (LSOA)) [29, 30]
- Latitude and longitude (based on Practice Postcode centre point, used to generate an inter-practice distance matrix) [31, 32]
- GP full time equivalents per 1,000 registered patients [33]
- Practice level registration data by age and sex [28]
- Measure of perceived supply derived from GP Patient Survey [13]

After matching practice level characteristics, the two variables were found to be incomplete: *GP full time equivalents* (21 missing, 13%) and *supply measure* (14 missing, 9%). A sensitivity analysis using binary logistic regression showed these to be unrelated to any other variable within the analysis. Missing at random values were imputed with the mean (of all four CCGs).

We included the hub/non-hub status of each practice as a binary variable, and the deprivation measure is the IMD decile, taken from the English Indices of Multiple Deprivation.

Variables used in the analysis are given in Table2. Appointments were grouped by practice to generate a count of uses for the year. The number of full time equivalent GPs working at every practice was also calculated per 1,000 registered patients.

To test whether there is a relationship between the use of an extended access service and distance we estimate count models of extended access service use with distance to the nearest extended access service and six additional covariates that we have reason to expect may predict service use. The

[2] An interactive term for practice mean age and female proportion was included in preliminary modelling work but this did not improve the model fit or yield any further associations.

dependent variable is a measure of use per practice and as such is a count variable. Count variables are often modelled using a Poisson framework however this can be biased where over-dispersion is present. In such instances a negative binomial model is used to account for over dispersion in the data [34]. The α parameter was selected using an auxiliary ordinary least squares regression without a constant [38]. Equivalising the response by the number of registered patients at each practice transforms the count of appointments taken from a discrete to a continuous value. Although this might seem to violate a required assumption for a count model, the discrete value cannot be negative and has the fundamental properties of a count, that is to say that it relates to a number of instances over a defined period of time. The practice list size has therefore in effect been applied as a weight.

Analysis was conducted in Python using the open source packages Pandas, Statsmodels and Numpy [35–37]. Visualisations were conducted in Python using Matplotlib and Seaborn [38, 39].

Results

Baseline characteristics of the variables in the analysis are given in Table 3.

Table 4 shows the breakdown of analysed appointments across the four CCGs. There are volume differences between CCGs. Some practices may not have advertised the service, others may not have the underlying unmet need. Some CCGs offered a much less extensive extended hours service. Practices are nested within CCGs, and the CCG has been included as a fixed effect to control for between-CCG variability due to organisational structure and the way in which the extended hours service was provisioned. We are unable to provide geographical visualisations of these data as we are required to preserve CCG and practice anonymity.

Distance is important in predicting service use rate (Table 5). As the distance to the nearest hub increases, so the number of uses observed at a practice over the year decreases. Figure 1 shows the predicted annual use rate by estimated distance to the nearest hub practice.

For a non-hub practice at 1km from its nearest hub, the predicted use rate is around 30 per 1,000 registered patients per annum. At 5km this falls to fewer than 10 uses per 1,000 patients per annum. Once CCGs were included within the model to control for between area variability, a greater proportion of female patients registered at the practice was not associated with increased use of the extended hours service in this model, in contrast with previous findings [12]. No age association was found and deprivation was not associated with rate of use. Hub status was associated with higher use rates. GP numbers and supply issues were not associated with the use rate. There were significant differences between some of the CCGs and we suggest that this could be attributable to between CCG differences in how the extended hours program was implemented.

Discussion

This study sought to determine whether distance and deprivation impact on the uptake of extended hours GP services that use a hub practice model. In line with previous studies [18, 20], we found that distance is important when predicting the use rate of the hub service for an individual practice. Hub status had a statistically significant effect, and we propose that familiarity plays a part in use of an extended hours services with patients more likely to use the service when it is located at their normal registered medical 'home'. We found no evidence that deprivation (as measured by the IMD decile of the home practice) was associated with lower use of the extended access service. The extent to which access to GP appointments has been improved through the extended hours service is difficult to discern from the data available. Female proportion was not significant in the model.

The presence of spare capacity in evaluations of extended access service uptake raises questions about whether access has improved for patients. Access is a multidimensional concept relying on availability, affordability and acceptability [14]. Availability may have improved through the generation of additional appointments; however, affordability and acceptability may still be restricted. We found that distance is an important factor in uptake. Distance from a hub location is a proxy for factors which affect the affordability dimension of good access. Practices which are further away from their nearest hub have much lower use rates of the service. The study considers appointments, aggregated to a practice level variable. Although these appointments are made and used by individuals, they are administrative units rather than people; uses rather than users. Individual motivations affect the underlying flow of appointments from the core provision to the extended hours, but there are also practice level effects, many of which are not captured here. The practice may serve a catchment with poor access to public transport or more restricted financial means restricting the flow of usage to an additional provider. The employment type prevalent in the

Table 3: Descriptive statistics for variables in the analysis

Variable	Mean	Standard deviation	Min	Max
use_rate	28.8	58.4	0	400
min_dist	2.02	1.59	0.0	7.44
mean_age	38.3	4.05	26.6	44.9
female_proportion	49.7%	1.9%	41.8%	54.5%
imd_decile	3.4	2.8	1	10
GP_per_1000	0.50	0.20	0.07	1.45
supply_measure	0.03	0.017	0.0	0.089

Table 4: Volume of use per CCG (N = 25,408 appointments)

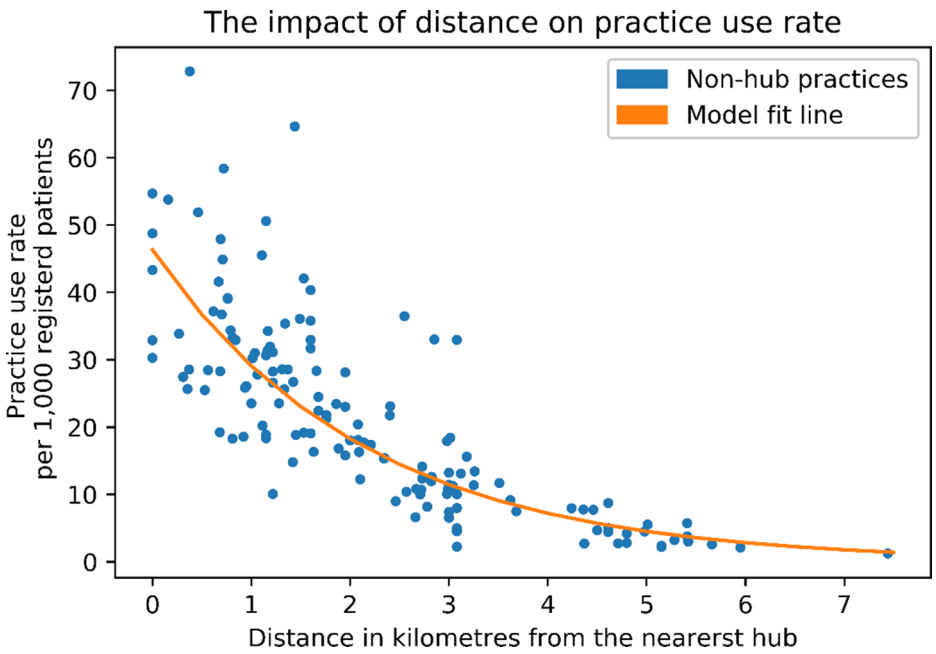
CCG	Number of attended appointments analysed	Appointments per 1000 registered population	Registered population
1	18,466	81.3	227,267
2	1,819	9.1	238,924
3	3,309	14.8	243,828
4	1,814	8.0	247,842

Table 5: Estimated model parameters (n = 25,408, AIC = 1,254.3, $\alpha = 1.46$)

	Estimate	Standard error	95% CI	
			[0.025	0.975]
Intercept	1.08	2.82	−4.45	6.60
min_dist	−0.28*	0.08	−0.44	−0.12
mean_age	−0.03	0.03	−0.09	0.03
hub	1.10*	0.39	0.33	1.86
female_proportion	0.08	0.06	−0.03	0.19
imd_decile	0.07	0.06	−0.04	0.19
GP_per_1000	0.49	0.53	−0.55	1.53
supply_measure	12.35	6.59	−0.57	25.28
CCG1	−1.43*	0.29	−2.00	−0.87
CCG2	−2.31*	0.29	−2.87	−1.75
CCG3	−2.62*	0.38	−3.37	−1.88

*indicates significant at the p<0.05 level.

Figure 1: Predicted annual use rate by distance to hub practice[3]

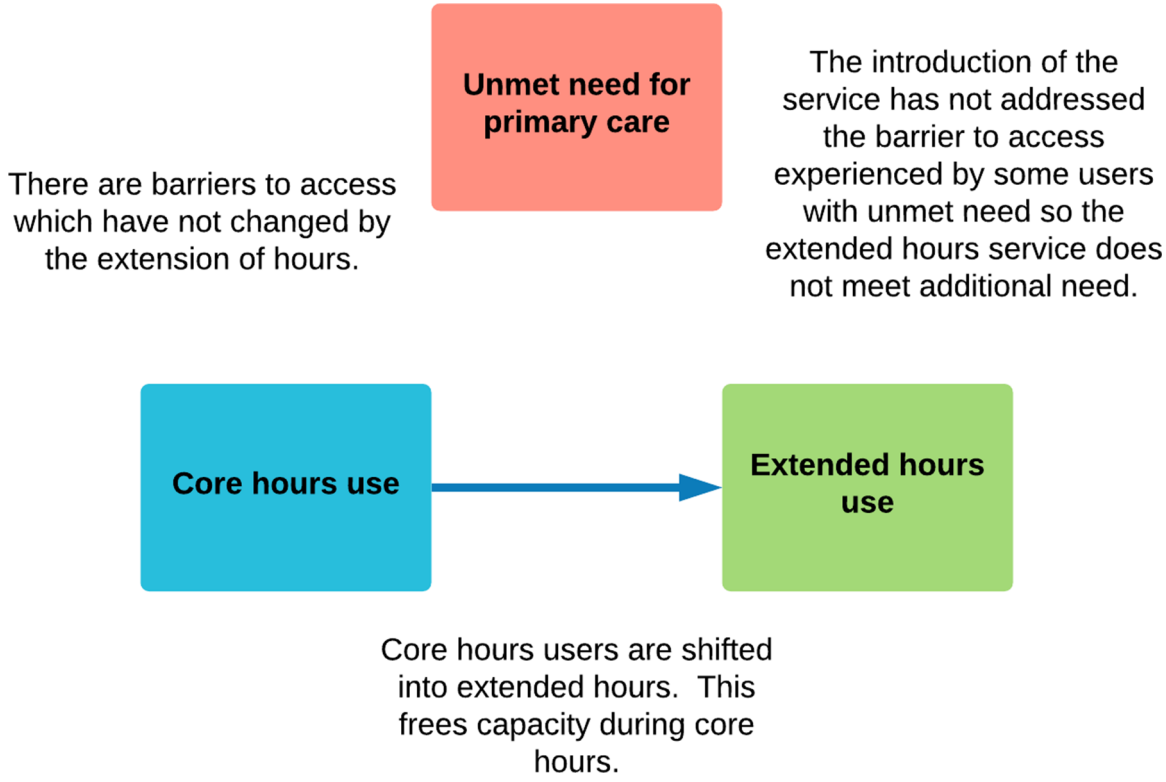


area may place time cost restraints which affect the ability for appointments to flow to a different location, an effect that increases with distance. There are effects at the CCG level which we are unable to explore with this dataset however it may be that different CCGs have advertised and implemented their extended hours services differently and that this has impacted upon the domains of access or simply through a lack of awareness that the service is available.

Familiarity may also be important in determining acceptability of appointments in distant locations – in many aspects of our daily lives, we are reticent to try out the unfamiliar and are often creatures of habit. It is therefore reasonable to expect that hubs which are further away may be

[3]This figure shows underlying data for non-hub practices, overlaid with a predicted fit line for the estimated model parameters using the mean for all variables except distance. Hubs have been excluded to allow better clarity of individual data points.

Figure 2: Unmet need remains unmet



less familiar and so the flow of appointments from the home practice into the extended hours service may be reduced. For hub patients, the implementation of the scheme simply offers them a wider window in which to experience the same service and greater flexibility in timing and so it makes sense that once a patient has decided to make an appointment to see a doctor, there is no structural barrier to the flow of usage between the core hours or extended hours service.

Research has found that having a medical "home" which is easy to access, leads to a more positive patient experience. Patients who see multiple doctors, report more errors in their care [5]. Accessing primary care through the extended hours service for patients of non-hub practices will necessarily involve travelling to an unfamiliar healthcare setting and the likelihood is that the patient will not see their usual core hours doctor. A hub service therefore threatens the concept of a medical home and there is a risk that the quality of primary care is eroded by the structure of the provision. The perception of eroded quality, concerns about having to repeatedly explain ongoing medical issues and the unfamiliarity of the setting may also pose additional barriers to using the extended hours service which are not measured in this study. It is proposed that the barrier to access for the service is to an extent a psychological one and as such the distance to the nearest hub is a good measure of dislocation from the service, even where users are opting to use hubs which appear to be further away.

Figure 2 provides an approach to visualising the above explanations for the results. The figure describes a use scenario where patients make use of the extended range of options, but the unmet need for primary care is not itself affected despite the extension of hours because the barrier to access for these patients has not been caused by the unavailability of appointments. Here a patient who would have used a core hours appointment is now choosing to use an extended hours appointment. This would increase free capacity during core hours but potentially does nothing to impact access for patients in the unmet need group. In this model, additional core hours provision may be wasted.

Figure 3 describes a use scenario where patients with previously unmet need are using the extended hours service as well as the core hours. Access has been enabled through two mechanisms – provision of additional choice over appointment timing, and consequential increase in core hours capacity. In this scenario, the barrier to access for this unmet need is the availability and timing of appointments, which has been addressed by the extended hours service provision.

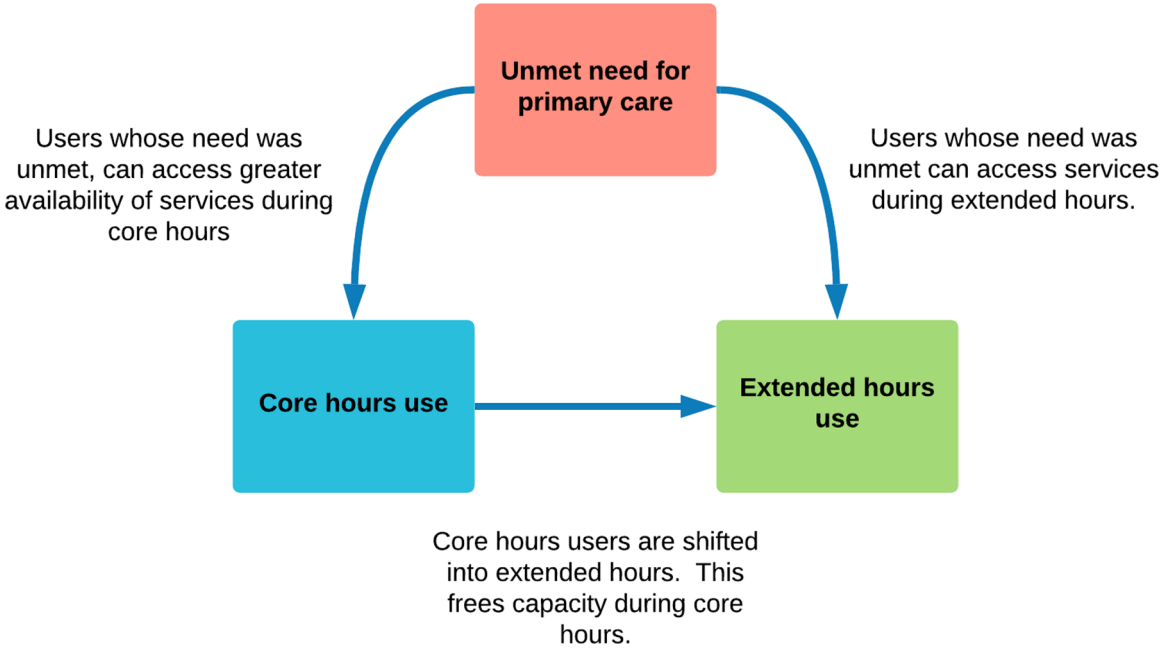
There are intermediate use scenarios which fall between these two theoretical examples – for example where unmet need is serviced by the extended hours only, with no core hours shift, or conversely where unmet need is met wholly through relaxation of overcrowding in core hours caused by core hours use shift.

Limitations

This study was limited by a lack of more granular geographical data and of detailed information at the individual level, particularly pseudo identifiers and a lack of home postcode data.

Only the home GP practice postcode is known for each use instance. The distances were calculated as a straight line between the home practice, and the nearest hub practice. The

Figure 3: Unmet need is met through two mechanisms



distance[4] travelled to attend an extended hours appointment is likely to be misclassified in all cases as patients living in the geographical extremes of each practice may need to travel significantly further or experience distance effects in the other direction. For patients at a hub practice, the minimum distance in this model is zero, however these patients are all likely to have travelled more than this to attend. For non-hub practices, the distance is likely to be underestimated in 50% of cases, assuming the registered practice is located at the centre of its catchment. This means that more than 50% of distances will be misclassified and an underestimate, but this is deemed to be a random effect and thus treated as a rescaling that does not introduce bias into the model.

The socio-demographic characteristics for each use instance were necessarily assigned at the practice level using the 2011 LSOA. Practices serve a catchment which may include a range of socioeconomic settings. Even within the same LSOA assigned to a deprivation decile, two streets of houses might be experiencing radically different socioeconomic circumstances. The use of practice postcodes as a proxy for patient location will have caused some misclassification which may have affected the performance of the IMD score in the model[5].The results of this study are specific to the four CCGs examined here and may not be generalisable across the rest of Greater Manchester or the UK. CCGs have the freedom to design the service as they see fit and so there may be structural differences and effects which impact the extent of uptake here, which do not apply elsewhere.

A measure of core hours capacity and use is not available in this dataset and so it is impossible to determine whether the use of the extended hours appointments represents a true increase in access, or whether it simply reflect a shift in uses for patients who already experienced an adequate level of empowerment or those who did not. The main consequence of this is that we are not able to distinguish between the candidate scenarios captured in figures 2 and 3. Further research using more detailed and comprehensive data is needed to clarify this important point.

Seasonal effects in utilisation were also not analysed here; it may be that there is still some compromise of availability during times of greater patient need, such as during the winter. Time stamp information is available in the dataset but the low quantity of data for some practices made it impossible to model using both time and practice level geocoding. Availability is not however the only determinant of whether a patient can access an appointment and so it is important to emphasise that spare capacity in the system does not necessarily mean that all need for primary care has been met, for example, the way in which patients were made aware of the service could also impact on uptake.

We do not know the health outcomes of service users and so the study does not explore whether or not the extension of primary care hours results in health benefits to the users or results in ineffective access and return visits to the patient's home practice.

Conclusion

The aim of providing primary care appointments outside of core hours is to improve access. The extension of hours

[4]We tested network distances in the original modelling and the results were near identical. Network distances and the measure used here are highly correlated for this particular area (Pearson's coefficient 0.96). The principle of parsimony and replicability suggests that the Euclidean method is more appropriate in this case.

[5]The Modifiable Area Unit Problem is relevant to any measure at the LSOA level. In the paper this only applies to the index of multiple deprivation. It turned out to not be associated with the outcome measure after controlling for other factors, but this could simply be to do with the misclassification of the LSOA, rather than the lack of a deprivation effect itself. From the data we have, we cannot say. We have been forced to use the practice level deprivation, and acknowledge that this may misclassify uses but we have limited options here other than to have excluded it entirely. We have not used any other measure at the LSOA unit here e.g. disease burden.

as a mechanism of increasing access is predicated on the assumption that unmet need is caused by a lack of capacity at an appropriate time. This may be due to overcrowding of services in core hours, or it may be due to the unsuitability of core hours for some primary care users.

Patients want, and use, extended hours services; however distance and familiarity are two potential barriers to equal access for all. The study suggests that patients living further away use the service less. For patients who cannot travel, or are unwilling to accept an appointment somewhere other than their medical 'home', the extended hours service may not be an effective way of improving access.

A simple view would be that if there is spare capacity in the system, then all needs must be met. However this analysis provides evidence that spare capacity in the system does not of itself demonstrate that access issues have been eradicated. It may be that patients who are already empowered to access health care are simply being given more choice, with no increase in the provision for those whose needs are not currently met, or it may be that the increase in provision increases access. Provision of ever greater service volume without consideration of the way in which people are motivated to use it, risks leaving those groups with unmet needs behind and reporting spare capacity risks hiding this unmet need in the data.

Policy makers and health care commissioners need to understand the differences in the extent and nature of uptake to inform their design and evaluation of future services. They should consider whether or not this type of model works to provide additional access and may use the findings in this study to inform the selection of hub practices – perhaps focusing on practices which minimise the average distance travelled for patients, or where there is relatively greater evidence of constrained capacity. This is particularly of importance in the context of closing health inequality gaps as those who are least enabled to access services may be those who need them the most.

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Statement on conflicts of interest

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and have the following competing interests: funding support from NIHR and from Greater Manchester Health and Social Care Partnership for this work; WW reports grant funding for other work from the Department of Health Policy Research Programme and NIHR. No other relationships or activities that could appear to have influenced the submitted work are declared.

Ethics statement

The study was reviewed by the University of Manchester's internal University Research Ethics Committee and approved under the low risk procedure and thus did not require UREC approval (ID: AMBS/16/05). The study involves anonymised administrative data and did not impact on the type of care patients received, consent by patients using the service was not required.

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Abbreviations

CCG:	Clinical Commissioning Group
GM:	Greater Manchester
GMHSCP:	Greater Manchester Health and Social Care Partnership
GP:	General Practitioner
GPPS:	General Practice Patient Survey
IMD:	Index of Multiple Deprivation
LSOA:	Lower Super Output Area
NHS:	National Health Service
NIHR CLARHRC GM:	National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care Greater Manchester